I N S E C T S
D E S T R U C T I V E
TO
W H I T E F I R C O N E S A N D S E E D S.

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INTRODUCTION.

The studies on which this paper are based have been made by the writer since appointment to the U. S. Bureau of Entomology, Forest Insect Investigations, in Aug. 1914. As the investigations at the Pacific Slope Sub-Station at Ashland, Ore, to which the writer was assigned, were in connection with the insects destroying the coniferous seeds of the Pacific Slope region, it was suggested by the Entomological Assistant in Charge, Mr. J. M. Miller, that the insect injury to the White Fir cones and seeds be taken up and thoroughly worked out.

To Mr. Miller, the author is indebted for many helpful suggestions, and criticisms and general supervision of this work.

Up to the time that investigations of coniferous seed damage were started by Mr. Miller in 1911, very little was known about the insects working in White Fir cones. A few of them had been described, but nothing was known of their life histories. At present, of the 18 species studied in this paper, only five have been previously identified.

As to the past history of the insect depredations upon White Fir cones, nothing has been learned. It is probable, that there has always been some injury to these coniferous seeds, high in food value as they are, or in other words, that many of the species are indigenous. On the other hand, some of the species, such as the very destructive Dioryctria moth, have evidently been imported, For the evidence seems to be that is is only within the last few years that cone damage had been severe; and these moths, rare a few years ago, are now plentiful, with practically no parasitic enemies.

In the following is given an account of what has been learned to date regarding these insects and their habits.

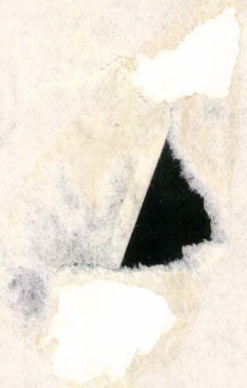

Fig. 1. Group of White Fir Trees. Siskiyou Mountains, Oregon. Note the sharp crowns of the young trees, and the drooping lowere branches of the older trees.

(Photo by Miller)

THE TREE .

One of the five most important trees of the Pacific Slope and Rocky Mountain region is the White Fir (Abies concolor Parry). It is described by the botanists* as a "tree 140 to 180 feet, occassionally 250 feet, in height and 4 to 6 feet in diameter, with an ashy gray, rougly furrowed bark which is from 4 to 6½ inches thick and very hard and horny. The trunk is straight and tapers very gradually. Young trees have beautifully symmetrical sharp crowns down to the ground, while the old trees have a dense crown of heavily foliaged short branches, the lower limbs drooping conspicuously, as do also those of the middle crown, while branches above this remain upright. Young foliage of the year is yellow-green with a bluish cast, but later it turns to a pale, yellow green, with a whitish tinge. The leaves are flat, straight, blunt or pointed. They stand out distinctly from two sides of the lower branches by a twist in their base, and are from 1½ to 3 inches in length. The wood is light, soft, rather coarse-grained, whitish to light indistinct brown; straight grained, works easily and is strong and hard enough to be useful for saw timber, for which it is used to some extent".

VARIETIES.

The Rocky Mountain form is the type of the species. The California form differs somewhat and has been considered a variety (var.lowiana Lemmon). This variety is intermediate between the Rocky Mountain form and Abies grandis; and is closely associated with it in Southern Oregon and Northern California. However, the two can be definately seperated by the character of the stomata on the leaves. Abies grandis has no stomata on the upper surface, while A. concolor possesses them either on the tip or completely covering the upper surface.

Abies concolor can be distinguished from other North American Firs by the flat leaves bearing stomata on the upper surface; the resin ducts which are small and close to the lower margin and the cone scale bracts which are ovate, shorter than the cone scales, with short points at the tip.

ITS RANGE .

The range of this tree largely approximates that of the Yellow Pine (Pinus ponderosa). It is found from Northern Oregon thru the ranges of California to Mt. San Pedro Martir in Lower California, eastward thru Southern Idaho, Nevada, Utah, Colorado, Arizona, New Mexico, to the State of Chihuahua, Mexico. It is found between 3000 and7500 feet elevation at its northern limit and between 8000 and 11,000 feet at its extreme southern limit. It generally occupies Northern slopes where the soil moisture is sufficient, and is very tolerant of shade.

ITS USES AND VALUE.

Although White Fir has never been considered a first grade timber tree, on account of the character of its wood and the amount of punk rot and wind shake which affects it,(about 15% being defective from this cause) of late years it has come more into favor as uses for its wook have been found, and where closer forest utilization has been practiced.

It is a useful tree for cooperage, second grade saw timber, box wood, ordinary construction, and to some extent for interior finish. Recently, the Crown Paper and Pulp Co. at Floriston, Cal. have found it to be a valuable wood for paper pulp, giving a fine grade of white paper, and they are, consequently making use of all the White Fir timber available.

Further than this it is a valuable tree for reforestation, particularly on moist morthern slopes, where on account of its tolerance will endure shade for many years. It has been estimated that there are 15,000,000 acres of brush on the National Forests which would support tree growth. 7,500,000 acres of this must be reseeded. Alarge part of this acerage is undoubtedly best suited to the growth of White Fir.

Taken on the whole then, itcan be considered a valuable and desirable species and its reproduction and continuance should be safe guarded.

Fig. 2.

Fig. 2. White Fir branch with 1913 (Old cones) and 1914 cones.

These cones show damage by White Fir Cone Moth.

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(Photo by Patterson and Keen)

Fig. 3. Cones showing comparison in size of smallest and largest White Fir cones collected during 1914. A Dioryctria larva's ventilating hole can be seen in the middle of the cone on the right.

(Photo by Keen and Patterson)

THE CONES AND SEEDS.

The cones which grow in an upright position on the branches, are foun in the very tops of the trees, generally those of fairly advanced age. "In dense stands the pole wood trees bear cones when the leaders have reached full light" The cone production" continues for many years, but is more abundant during rapid height growth than at maturity".

The mature cones vary in length from 2 to 5½ inches, in diameter from 1 to 1 3/4 inches. (Fig.3 illustrates the variation in size), and contain on the average about 270 seeds. They "mature early in Sept, when they are a very pale olive green, with an ashen tinge, or clear chrome-yellow green; sometimes purple". The bracts attached to the backs of the cone scales are rather narrow and oblong, broad and squarish at the breen end, which has a small point extending from its center. The seeds (Fig. 4) are a dingy yellow brown, about ⅛ inch in length, with shiny, clear, rose tinged wings" which are about ½ inch in length, widening from the seed to the broad, blunt apex. Seed leaves, 6.

When seeds are collected for planting the cones are gathered in Sept, and Oct. either from the trees or from squirrel hordes. The seeds are removed from the scales by (mixing with coarse gravel and churning, then) screening, The hollow seed and chaf are removed by passing thru an ordinary fanning mill. They should be stored in a cool dry place preferably in air tight receptacles and protected from the insects which feed on such stored material. They are then sown the following Spring, after their collection, as they quickly lose their vitality.

Seeds are sold by professional forest seedsmen from $1.50 to $5.00 per lb. But with the increase in insect damage, and the seeds harder to obtain, they must necessarily advance in price. An estimate of the Forest Service on one sample of seed collected by them, placed the cost of such collecting at $10.75 per lb; a prohibitive price.

REPRODUCTION.

Reproduction occurs only thru the agency of seeds. White Firs do not sprout as do the Redwoods, and some other Forest trees.

Sudworth states that it is a "fairly prolific seeder. Good seed years occur at irregular intervals of two to three years or more, but some seed is produced every year. Seed of only moderately high rate of germination, often under 40% and with only transient vitality. Character of seed bed apparently of little importance, germination taking place on heavy litter and humus, as well as in mineral soil, but fairly abundant soil moisture is essential for establishing seedlings. Indifference to kind of seed bed renders it aggressive, for reproduction occurs over denuded lands as well as under its own shade."

As has been stated, seed years occur at irregular intervals of 3 years or more although some seed is produced every year. The cause of this irregularity is not thoroughly understood. It may be due to climatic conditions and it has been observed that drought one year causes a good seed year the next. This follows the rule of all plants and animals which tend to increase reproduction when a decrease in food supply, disease or other detrimental conditions tend to lower their vitality or threaten their existence.

This irregularity of cone production may be an important factor in saving some seed for reproduction. For if a good crop was produced each year, insects and rodents would become so abundant that all of the seed would be destroyed. Even with this irregularity, insects are found to adapt themselves to the condition and retard their emergence over two or more years, so that in the case of a cone crop failure, the species will not become extinct.

RELATION OF INSECTS

Of late years, the insect damage has so decreased the amount of good seed that private seed collectors and the Forest Service have been unable to obtain sufficient quantities of fertile seed in any one locality to make its collection profitable.

It is the object of this paper to show what this insect damage amounts to; the species involved; the character of the work of each; the parasites which hold them in check; and the affect which these insects have upon the reproduction of this tree. And as far as possible point out methods for avoiding loss from the collection of poor seed.

Localities Representes.

During 1914, White Fir cones were examined from several different areas widely separated. They represented the cone crops from Ashland, Oregon and vicinity; Northern California; Sequoia National Park, Calif; and El Paso Colorado.

These cones varied in size and color as well as in the amount of damage suffered by them. Fig. 3 shows the difference in size between the smallest cones which were collected near Ashland, and the largest ones which were obtained from the Sequoia National Park, Calif. These small cones contained very inferior seed, while the large ones from the Park were almost perfect cones, with very few blighted seed and a small percentage of infestation.

It is interesting to note that the species involved in the cone damage were practically the same from each locality.

CHARACTER AND CAUSE OF DAMAGE.

White Fir cones have probably suffered more from insect attack than any other coniferous tree. And the species involved are more numerous and diverse than those found in other cones.

They represent the Orders, Lepidoptera, Diptera nad Hymenoptera, and each species does a particular type of injury. Some of the larvae bore thru scale and seed; others attack the cone while quite immature causing a large amount of resin to flow, thus hindering the developement of both seed and scale.

Fig. 4. Good Seed, showing external and internal appearance.

(Photo by Keen and Patterson)

Fig. 5. Blighted Seed. -sectioned longitudinally and laterally to show hollow interior and woody shells.

(Photo by Keen and Patterson)

Others attack only the seed while still others live upon and in the scales.

In the scae of the boring caterpillars, their work is evidenced by powdery larval castings on the surface of the cone or masses of pitch and abortion. The seed infesting insects are only to be found upon examining the seed, and those within the scales by sectioning it. Those insects which simply inhabit the cones, such as one species of Cecidomyid, leave the cones in great numbers when they are placed to dry.

In this paper the seed have been divided into three classes and counted as such, namely Good seed, Blighted seed, and Infested seed.

GOOD SEED.

Those seed are considered good where the embryo and endosperm are found filling the seed, with a plump and moist kernel. Fig. 4 shows the appearance and character of such seed.

When the cones are examined while green, a highes percentage of good seed is found than later in the season after the cones have begun to wither and dry. For, after the cones have been cut from the trees by squirrels or injured by insects many of the young seed which would normally develope, fail because of lack of nourishment and moisture.

On the basis of the cutting tests made of the 1914 crop of cones, only 21% were found to be normal. If, as stated by Sudworth, the germination of this seed is often under 40%, this would mean that only 8.4% of the total White Fir crop would be available for reproduction and when it is taken into consideration that a large part of the crop is eaten by squirrels and other rodents and that the mortality of young seedlings is very high, it is evident that the trees maturing from such a crop as the 1914 one, are very few indeed.

BLIGHTED SEED.

Under this title are included those seed which for some reason or other fail to properly mature yet do not show insect damage.

Fig. 5 shows a sample of such seed from two different lots of material. The seeds are of normal size but the seed coat is woody and the embryo and endosperm.

Fig. 6. Showing a Seed sample with the Different Types of Injury.

I. Seed chalcidid, 17 seed or 34% injury.

II. Dioryctria moth. 5 seed or 9% injury.

III. Small Pink Caterpillars, 3 seed and 6% injury.

IV. Evetria moth, 2 seed and 3 % injury.

V. Fir Seed Maggot, 1 seed or 2% injury.

VI. Blighted Seed, 22 seed representing 44%.

VII. Good Seed. 1 seed or 2%.

are shrivelled or entirely lacking.

In the dry cones the number of this class of seeds is greater than in the green ones, on account of the withering of many of the seeds which are not fully nourished. On the other hand, in many cones there are seeds of normal size but hard and woody and containing no germ. It is difficult to say just what this is due to. It may possibly be caused by a fungus or incomplete nourishment, but more probably it is due to lack of proper pollinization. It seems quite possible, that in the haphazard method of wind-pollinization, some seeds would fail to receive pollen. In which case the vegetative portion of the seed would reach normal size without the germ developing at all.

It is interesting to note from the tables that the percentage of this class of seed is fairly constant, averaging 42.8%. With a maximum of 46.5% and a minimum of 35.1%. This latter was from the exceptionally good lot of cones from the Sequoi National Park, Calif.

INFESTED SEED.

In this class are included all seed which are not only inhabited by the insects but also those seeds which are injured by boring moth larvae, and those which fail to develop because of injury to the scales.

Fig.6. shows a seed sample from cones collected near Colestin, Ore. This figure not only shows the class of damage done by each insect but the percentage done by each. 50 seeds are shown. I. shows 17 seeds containing seed chalcid or 34% of injury. II. shows the work of the Dioryctria moth with 5 seeds bored thru representing 9 % injury; III, is the work of the small pink larme doing 3% injury. V, shows 1 seed destroyed by Lonchaea and represents 2 % injury to the crop. 22 seeds VI, illustrate 44% of blighted seed, and 1 seed (VII) illustrate 2 % of good seed.

Following is a list of the insects and their work in destroying and infesting the White Fir cones.

Fig. 7. White Fir Cones injured by White Fir Cone Moth (Evetria Siskiyouana)

Note the resin masses and curved condition of the cone.

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(Photo by Keen and Patterson)

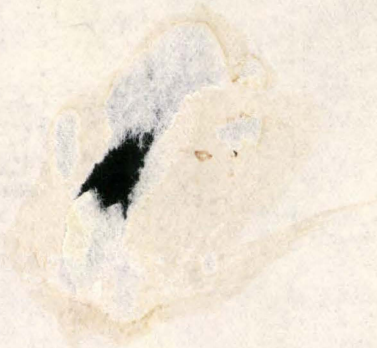

Fig. 8. Larva of White Fir Cone Moth feeding within cone.
Formalin speciman.
(Photo by Keen and Patterson)

Fig. 9. Pupae of White Fir Cone Moth in resinous cocoons on cone scales.
(Photo by Keen and Patterson)

Fig. 10. Transformations of White Fir Cone Moth.

(Photo by Keen)

Fig. 11. White Fir Cone Moth - adult. (Evetria siskiyouana)

(Photo by Patterson)

I. SPECIES OF INSECTS WHICH ATTACKED AND ABORTED THE CONES SO AS TO RUIN THE SCALES AND SEEDS? OR WHICH KEPT THE SEED FROM MATURING.

A. White Fir Cone Moth, (Evetria siskiyouana)

Description:-
Larvae;-11mm. long, 2½mm. wide, yellow white. Body composed of 12 segment back of the head, with 14 to 16 scattered short yellow bristles on each segment. Head dark brown to black with chitinized plate extending back over 1st. thoracic segment. 3 pair of legs. 5 pair of prop legs on the 6th, 7th, 8th, 9th and 12th segments.
Pupae:-dark reddish brown to black, 8mm. long.
Adult:-gray moth with fore wings speckled with black and tipped with brown. Wing expansion 24 mm. Body 6mm.

The pupae of this moth, which may be observed from July 1st until the latter part of the following April, is always found in a papery cocoon imbedded in masses of resin near the axis of the cones. (Fig. 9) The larval borings can in many instances be traced thru the scales and seeds and seems to cause much flow of resin.

A few cones collected July 18th and placed in formalin were examined and the larvae found in position boring thru the scales and seed. (Fig.8) These larvae had attacked the cone while it was quite young and had arrested the growth of one side of the cone, while the other side continued to grow and mature. This larval work causes an aborted curved cone with one undeveloped side. The aborted side is a mass of exuding resin with the small under developed scales matted together.

The life cycle of this moth is completed in a single generation. From the first of April to the latter part of May, the adult moths deposit their eggs upon the young and tender cones. The eggs hatch and the young larvae bore into the heart of the cone feeding as they go upon the scales and seeds. The larvae reach full growth by the middle of July and in the center of the cone among the resin matted scales, they form a papery resin coated cocoon in which they transform to pupae. In this condition they pass the winter, emerging as adult moths the following Spring. Thus completing the life cycle.

In estimating the damage done by this moth, the injured scales, which would have normally borne two seed, were counted and this number multiplied

Fig. 12. Small Pink Caterpillars in seed (on left) and in winter quarters on scale(at right).

(Photo by Keen and Patterson)

by two. In other words, the damage caused by this insect was estimated so as to include those seeds which would have normally developed had it not been for its presence.

As will be seen from the table of damage, this moth was held accountable for the highest percentage of damage, 29.9% of the insect damage was done , while it destroyed thru its work 10.9% of the total seed crop.

B. Small Pink Caterpillars. (Species?)

Description:-

Larvae:- Very variable in size, from 4 to 12 mm, averaging 9 mm. in length. Light pink body with darker pink stripes on anterior dorsal half of segments. 12 segment s back of the head, with 3 true legs and prop legs on the 6th, 7th, 8th, 9th and 12th segments. 16 to 18 long yellow bristles arranged on each segment. Head with chitinized plate extending back over upper half of 1st. thoracic segment. Very active.

Pupae:-not known.

Adult:- not known.

These active pink caterpillars seem to damage the cone both by boring thru the seeds and scales and by feeding upon the seeds directly.

They enter the cones by boring between the scales, then bore along the cone axis as they go. They also bore directly into the seeds eating the contents and then leave them thru the same hole (near the point of attachment of the seed) or in some cases bore out thru the opposite end. (Fig.12)

Some of the larvae prepare for the overwinter period, by spinning silky cocoons about themselves within the cones (Fig. 12) generally between the seed wing and the cone scale, while others leave the cones and form their cocoons on the sides in crevaces or on the bottoms of the breeding boxes. The larvae, which overwinter in this condition probably again attack the cones in the Spring. (No upupae have been found.)

These caterpillars were nearly as destructive as the cone moth to the 1914 crop of cones, being responsible for 22.5% of the damage done by insects and destroying 8.1% of the total 1914 seed crop as examined.

Fig. 13. Work of Dicrycstria larvae in the center of the cones.

(Photo by Keen and Patterson)

Fig. 14. Pupae of Dicrycstria in dirt covered cocoons at margin of cone scales.

(Photo by Keen and Patterson)

Fig. 15

Fig. 15 Transformations of Dioryctria moth from larva to adult.

Showing the coiled position of the prepupal larvae.
(Photo by Keen)

12538f-2

Fig. 16

Fig. 16. Dioryctria r[illegible] - adult.

12538f-2

(Photo by Keen)

C. Dioryctria moth. (Dioryctria sp)

Description:-

Larvae:-17 mm long, 2½mm wide. Long irridescent greenish red caterpillar with body composed of 12 segment s back of the head, with 18 to 20 long yellow bristles on each segment. Head, light brown with a chitinized plate extending dorsally over 1st thoracic segment. 3 pair of true legs, 5 pair of prop legs on 6th to 9th and 12th segments. Very active.

Pupae:-dark reddish brown chrysalis, 11mm long.

Adult:-Gray moth mottled with black. Wing expansion 26mm. body 12mm.

The larvae of this moth bore thru the center of the cones making circular holes thru scales and seed (Fig. 13) Its presence in the cone can generally be detected by the large amount of larval castings which it discards thru its ventilating holes. One of these holes is shown in Fig. 3 in the center of the large cone. In contrast to the cone moth, previously described, its work does not seem to cause a flow of resin. Its tunnels are round and clean cut and its castings free from pitch. It does not seem to prefer the seed but bores indiscriminately thru seed and scale.

The larvae when pupating select a place either between the scales or on the surface of the cone or in the ground and in a coiled position spin a flat silky cocoon about themselves. Some of the larvae transform to pupae during September, while others remain overwinter in their coiled position within the dirt covered papery cocoons. Fig. 15 shows the way in which these moths change from caterpillar to pupae, and Fig. 14 shows two of these pupae in their cocoons at the edge of the cone scales.

There appears to be two annual generations of this moth. Those moths w which pupate in the fall and those which overwinter as larvae probably emerge in the spring and lay their eggs in the young cones. These larvae develope with the cone during the summer, pupate and emerbe as adults from the middle of August to the middle of September.

In estimating the damage done to the 1914 crop of cones by these larvae those seed were counted which had been bitten into, while making their tunnels. They did an estimated damage of third greatest importance, destroying 8.0% of the total seed crop and were responsible for 22.2% of the work done by insects.

Fig. 17. Larva of Large Cone Maggot in its gallery within the cone.

12538

(Photo by Keen and Patterson)

Fig. 18. Transformations of Large Cone Maggot from larvae to adult. Note the posterior end of the puparia with the numerous projections which differentiate it from the very similiar puparia of the Fir Seed Maggot (Fig. 24)

12538 b.

(Photo by Keen)

D. Large Cone Maggot. (Fam. ~~Tachinidae~~ Anthomyidae)

Description:-

Larvae:-8mm long, 2mm wide tapering to the head. Body white in color composed of 13 segments. Head with two great hooks. Anterior spiracles with 18 lobes.

Pupae:-Dull yellowish-red to brown coarctate puparia;6.5mm by 2.5 mm. Old anterior speracles remaining as two large anterior projections Posterior end more or less blunt with numerous small projections representing the larval apical spines. Body slightly annulated.

Adult:-(very probably from the above larvae) Black body, 5mm. long, covered with bristles, thinly pilose. Eyes bare. Front with a row of bristles extending below base of antennae. 1st antennal joint short, 2nd shorter than third. Arista bare. Wing venation simple, 1st posterior cell nearly closed. Squamae large.

The larvae of this fly bore thru the scales and seeds thru the heart of the cone, leaving a mass of pulverized material in their wake. Several larvae were found in cones placed in formalin July, 18 1914. (Fig. 17) They were found in galleries approximate to those of the Evetria moth, and it is quite possible that they are parasitic on this moth. However, the evidence seems to show that they are not parasitic but feed upon the cone. Their galleries are distinguishable from those of the Evertia by the very ragged margins which are undoubtedly due to the tearing action of the two great hooks, carried by the larvae.

The puparia which resembles that of the common Lonchae, found so abundantly in some cones, can be distinguished from the latter by being found within the cone, while the Lonchaea puparia is always formed in the soil; by its larger size and duller color; and by the absence of the two prominent anal tubercles possessed by the latter.

Further observations will be necessary to determine the precise habit of this dipteran and its life history.

E. Small Cone Maggots.

Description:-

Larvae:- Very small almost colorless larvae,2mm in length. Mandibles apparently united at middle but divergent at apex. Cephalophargyngeal skeleton and mandibles black and quite prominent. Two anal tubercles conspicuous.

Pupae:- not known.

Adult:- not known.

These very small maggots were found in abundance in cones collected

Fig. 19. End view of Cones ruined by Small Cone Maggots.

12560s-2

(Photo by Keen and Patterson)

Fig. 20. Cross-section of Maggoty cones from Ashland, Ore,

and normal cones from Colorado.

12560 s-2

(Photo by Keen and Patterson)

both from the trees and the ground near Ashland, Ore. on Oct. 23, 1914, These maggots had riddled the cones from end to end so that not a single seed had escaped. The whole interior containing nothing but a mass of larval castings. Fig. 19 shows an end view of these cones with their pulverized interiors. Fig. 20 shows a comparison between these cones and cones collected even later in the season from Colorado. The Colorado cones did not contain this larva and consequently showed a normal number of good seed.

The damage was done after the period of seed collecting and so does not appear in the table of seed damage.

II. INSECT SPECIES ATTACKING AND DESTROYING THE SEEDS ALONE.

A. Seed chalcidid. (Megastigmus spermotrophus and M. pinus.)
Description:-
Larvae:-Small white gootless larvae, 4 to 6 mm. long tapering to both ends. Body composed of 14 seqments. Mouth-parts slightly differentitated with chitinized mandibles.
Pupae:-White, not enclosed in a cocoon, slightly shorter than the larvae.
Adult:-M. spermotrophus-Body light yellow 4 to 5 mm long (exclusive of ovipositor) males somewhat smaller. Fore wings with a prominent clubbed stigma below middle of anterior margin. M. pinus- similiar to above but body black with yellow markings.

Most important as seed destroyers are the seed chalcidids. These small larvar are found in the middle of what appear to be perfectly normal seed. They seem to grow and develope with the seed and cannot be found until the seed is cut open. In one lot of material examined, 33.6% of all of the seed contained chalcid larvae.

Fig.22 shows a group of sectioned seed from this lot of material with the contained larvae. It will be noticed that the seed is completely hollowed out, nothing but the shell remaining. Fig. 21 shows the development of M. pinus from larvae to adult, as was worked out in 1913 from specimens found in Red Fir seed, by Mr. Miller.

Cones placed in formalin July 18, 1914. were examined and very small young larvae about 1 mm in length were found in the center of what appeared to be normal seed. They had already succeeded in eating out quite a large cavity in the very center of the seeds.

Fig. 21. Developement of Megastigmus pinus from larvae to adult.

Upper row of females. Lower row of males.

11489 (Photo by Miller)

Fig. 22. Seed Chalcidids in White Fir seeds.

12538-2 (Photo by Keen and Patterson)

The eggs are deposited by the femals in the very young seeds during late spring and early summer. These hatch, probably within a few days, and the young larva, surrounded with an abundance of food, feeds with very little exertion in the middle of the seeds, until the following spring. Pupation occurs during March and adults commence their emmergence by the first of April.

The males of M. pinus are found to be the first ones to emerge. They come out from April 1st until June 1st. The females make their appearance about April 11 and both sexes reach a maxium emergence about May 1st.

Again in the case of M. spermotrophus, the males are slightly in advance of the females, both sexes emerge from about the 1st of May until the 1st of Aug. reaching a maxium emergence about June 16th.

As has been found, all of the seed chalcidids do not emerge after the first year but remain in the seed as larvae until the second and even the third year. This phenomena enables them to adapt themselves to the irregularity of the cone production. If the entire brood emerged the first spring and the cone crop failed that year; the species would become extinct from lack of food. But by holding over in the seed, they are enabled to attack the second or even the third year crops and in this way perpetuate the species.

They were the fourth most destructive pest of the 1914 cone crop, responsible for 21.1% of the insect damage, and destroying 7.6% of the total seed crop of that year.

B. Fir Seed Maggot. (Lonchaea ruditarsis. Macq)

Description;-

Larvae;- White, footless larvae about 8mm long and 1mm. wide. Body compose of 12 distinctly constricted segments all roughened by very small bristles tapering to head. Anterior spiracles fan-shaped with 12 lobes on tip, Head with two large black hooks or mandibles attached to cephalopharyngeal skeleton which is also black and plainly visible thru skin. Posterior end without Prominent apicle spines but with two prominent chitinized blunt anal tubercles.

Pupae;-Dark red coarctat puparia 5.5mm by 175mm. Finely annulated. Anterior end with two projections, remnants of the anteriorspiralcles. Posterior end more or less rounded with two.

Fig. 23. Fir Seed Maggots in Seeds.

12560

(Photo by Keen and Patterson.)

Fig. 24. Transformations of Fir Seed Maggots. Note the characteristic 2 anal projections of the puparia. (Photo by Keen.)

11441a 12547c

Fig. 25. Adults of Fir Seed Maggots. Lonchaea rufitarsis.

11441o (Photo by Keen)

prominent blunt projections, remnants of the anal tubercles. These puparia differ from those of the large diptera by their smaller size and by having the two prominent anal projections.

Adult: Rather small metallic black flies. Bodies 4.. long wings much longer than abdomen, 5,, long. Front rather narrow, with single orbital bristle. Auxiliary vein of wings distinct, basal cells present.

Upon breaking open a White Fir cone during Aug. or Sept., these white footless larvae may be seen wriggling out of the seed near its point of attachment. Fig. 23.

They seem to feed entirely within the seed but their work can always be detected, for they leave an exit hole, and the seed is flat and limp, and generally almost black in color after they have destroyed its interior.

It has been observed that these flies emerge from about Mar. 9th until May 13th, with the maximum emergence occuring about the first of April. They then attack the young cones, apparently laying their eggs within the young seed, for small larvae about 1 mm in length have been found in the very center of the seed on July 18th. They develope in the seed during the summer, leaving a hole thru the seed near its point of attachment. In September and October they leave the cone, drop to the ground and form their reddish brown puparia in the soil.

Mr. Miller has observed that after the first winter, only a few of these flies emerge, the main part of the brood remaining in the soil until the second year. Here is another case of the adaption of the life cycle of the insect to its intermittent food supply.

Fig. 26

Fig. 26. Seed Cecidomyids, in position within the seeds.

125546

(Photo by Keen and Patterson)

C. Seed Cecidomyid.

Description:-

Larvae:- Small pink salmon colered 3.5 mm long. Body composed of 14 segments. Head not differentiated, jaws rudimentary, two large two-jointed palpi. Last abdominal segment with two smoothe rounded tubercles. On under side of 1st thoracic segment, a Y shaped sclerite or "anchor process". Alimentary canal showing thru orange from above.

Pupae:- naked, not coarctate, pink, somewhat smaller than larvae.

Adults:- (species not yet differentiated) small salmon, colored flies very delicate and covered with hairs. Body about 1.5 mm long Legs long slender without tibial spurs. Wing venation simple with few longitudinal veins. Antennae of about 16 joints, joints, pedicelate.

One specie of this family was recently found inhabiting and destroying the White Fir seed. (Fig. 26) These small larvae are found inside of the seed near its point of attachment and completely enclosed within it. As in the case of the seed chalcidid, it can not be found until the seed is sectioned. But its presence can often be detected by the general appearance of the seed which is generally light in color, aborted with the seed coat hard and brittle in texture. These larvae are not found in the Colorado cones but appear to be restricted to the California and Oregon ones.

D. Small Microlepidoptera.

Description:-

Larvae:- Small, white caterpillars 5 mm long about $\frac{1}{2}$ mm wide. Body composed of 12 segments back of the head. 3 pair of true legs on the thorax, and 5 pair of pro legs on the 6th to the 9th and on the 12th segments. Segments with about 16 scattered white hairs. Head black. Upper side of 1st thoracic segment with a black plate.

Pupae:- not known.

Adult:- not known.

A few of these small caterpillars are found infesting the White Fir seed. They seem ot bore into the seed near the point of attachment and feed upon the contents, in much the same way as the long dipterous larvae.

The adult moth, and the life history of the specie are as yet unknown.

Fig. 27. Cecidomyids in Gall Pockets on Cone Scales of White Fir.

12554

(Photo by Keen and Patterson)

III. SPECIES LIVING WITHIN THE CONE BUT DOING NO SEED DAMAGE.

A. Cecidomyidae (2 species)

Description:-

Larvae:- (1) small, pink or salmon colored to almost white. 3.5mm long. Body composed of 14 segments. Head not differentiated jaws rudimentary, 2 large two-jointed palpi. Last abdominal segment with two small rounded tubercles. Under side of 1st thoracic segment with a Y-shaped sclerite. Alimentary canal showing thru green and later yellow from above. Travel by crawling with a flowing motion. Found in hard gall-like swellings on the cone scales.
(2)m larvae of reddish color similar in size and appearance to the above, but differ by having the last abdominal segment two horny processes. Travel by curling up and snapping. Do not form a gall.

Pupae:- not known.

Adult:- (not yet differentiated) general characters similiar to those of the seed cecidomyid described on page .

Besides the cecidomyid found in the seed, there are two others found in the cone. One of these (no 1) is found in small gall pockets on the scales attaching in many cases the seed and scale together. Fig. 27 shows the larvae in position. They do no important damage to the cone.

The other larva (No 20) is quite abundant in all cones. It is often found in small masses of resin on the surface of the cone scales or between the seed and wing. When the cones are placed on sheets to dry, these larvae emerge in great numbers. They also, do no apparent damage to the cone.

B. Long cigar-shaped gnat larvae (Mycetophilidae)

Description:-

Larvae:- Long cigar-shaped salmon colored larvae about 3 mm long. Body composed of 13 segments. 7 pair of very small nipple shaped pseudopods on the 4th, 5th, 6th, 7th, 8th, 9th, and 10th segments. Head not diff erentiated.

Pupae:- not known

Adult:- not known.

These larvae are found along the axis of the cones. They are probably not responsible for any damage. But probably live upon the fungus found along the axis of the old cones .

Fig28

Fig. 28. Ichneumon larva in Cocoon of Evetria moth and adult Ichneumon.

12560 (Photo by Keen and Patterson)

Fig. 30. Larvae of Chalcid parasites of Evetria moth as seen within the cone in Fig. 29. Larvae of Chlacid parasites filling Evetria Galleries.

12538 (Photo by Miller and Keen)

filling larval skins of Dioryctria larvae.

12538 (Photo by Keen and Patterson.)

IV. PARASITES ON THE CONE INSECTS.

A. Ichneumons. (Ephialtes sp. and Homolomna sp.)

Description:-

Larvae:- Yellow white, 6 mm long, 2 mm wide tapering to both ends. Body composed of head and 13 segments. Antennae of two small bristles.
Pupae:- not known.
Adult:- Shiny black body 9mm long Ovipositor of female 11mm long. Wings clear with iridescent green and red splotches. Coxae, trochanter and femora reddish yellow, tibia and tarsus black. Stigma consisting of black triangular splotch on anterior margin of fore wing.

These parasitic larvae are found in the resinous cocoons of the cone moth Evetria siskiyouana. (Fig. 28) They probably lay their eggs in the young caterpillars of the moth. The young then develope with the caterpillar completely devouring it after it has formed its cocoon. About 25% of the Evetria moths were parasitized by these ichneumons.

B. Small Chalcid Parasites.

Description:-

Larvae:- small white footless larvae, 2mm long. Body composed of 14 segments, tapering to both ends.

Pupae:- Black, naked 2 mm long.
Adult:- Small black wasps, 2 mm long. Antennae with 6 joints. Wings with simple venation, stigma without swollen club but with hook directed backwards and upwards. Ovipositor shorter than abdomen.

Many colonies of small chalcids are often found to completely parasitize the pupae of the cone moth and the larvae of the Dioryctria moth.

Fig. 29 shows these small larvae completely filling the larval skins of the parasitized dioryctria caterpillars. In cones collected from Colestin, Oregon, these were quite abundant, parasitizing a large percentage of these caterpillars.

Fig. 31. Humenopterous parasites of Seed Cecidomyids.
12554 (Photo by Keen and Patterson)

Fig. 32. Hymenopterous parasites of Scale Infesting Cecidomyids.
12554 (Photo by Keen and Patterson)

C. Clerdae:-

Description:-

Larvae:- Pink with flat brown heads and large mandibles. 8mm long 1.5 mm wide. Abodmen composed of 9 segments covered with hairs Last abdominal segment provided with two chitinized hooks. Three pair of legs on the thorax. 1st thoracic segment with a dorsal chitinized plate bearing a longitudinal dark line along its center.

Pupae:- not known

Adult:- not known

A few of these larvae are found in the drier cones. They probably are predaceous on any and all of the smaller larvae.

D. Small Black Wasps on Cecidomyids.

Description:-

Larvae:- not known

Pupae:- white 2mm long contained within the brown hardened cecidomyid larval skin.

Adult:- Very small black wasps, 2 mm long. Wings with no veins except at very base, covered with short bristly hairs. No stigma Antennae long, 11joints, 2nd joint much longer than others Ovipositor shorter than abodmen.

A very tiny black wasp os parasitic on the two species of Cecidomyids which form galls. This wasp apparently lays its eggs in the larvae and mature
mature within the larval skins, deriving their nourishment from the larvae

In October, the adults may be found about ready to emerge from the inflated, eliptical larval skins which have dried so as to form perfection cocoons for them. These cocoons are found within the gall pockets formed by the midgets.

E. Hyper-parasites on Ichneumons. (Peducalaria ventricosus)

These small mites were found in the breeding boxes of some of the White Fir cones, feeding upon the larvae of the parasitic ichneumons

They were also found in other lots of material, feeding upon various unprotected larvae, so it is probable that they originated in the breeding boxes and not in the Fir cones.

Besides the damage done by insects to White Fir cones, there are also other factors and conditions which tend to injure or destroy them.

Among these may be mentioned climatic conditions, such as severe frost; and rodent damage, especially that of the squirrel.

In the early summer of 1914, there was a heavy frost in the vicinity of Ashland, Oregon, which killed a high percentage of the young cones especially those at the higher elevations, so that the 1914 crop was very meagre in this vicinity.

The damage done by the squirrels is very hard to estimate. They horde, in some seasons, great quantities of the cones in hollow logs, by fallen trees, and under the banks of streams. Some of these are eaten while the great majority are left to decay, being so secluded as to prevent their germination.

There are doubtless many other factors which at times, enter into the destruction of the white Fir cones and seeds. But they are so variable that no account can be taken of them.

TABLE OF INSECT DAMAGE TO THE 1914 CROP OF WHITE FIR SEED.

In the following table the damage done by the Evetria moth, the pink larvae, the Dioryctria larvae and the large, conemaggot, represent seeds damaged but not necessarily inhabited or infested by them. On the other hand the number of seed damaged by seed chalcidids, Fir seed maggots, cecidomyid and small white caterpillars represent the number of larvae found as well as the number of seed infested, for only one larva was found in a seed.

It will be noticed that no cecidemyids, large cone maggots of small white caterpillars were found in the cones from Colorado.

The number of seed per cone was very constant. In cases where the cone scales were counted in the absence of seed, the resulting number was very close to the average for a normal cone.

SUMMARY OF IMPORTANT DATA SHOWN IN TABLES.

TABLE 1.

Insect Damage to 1914 Seed Crop.

This table shows that on the basis of 21,867 seeds in 82 cones examined, which represented the cone crops of Oregon, California, and Colorado, 36.2% were destroyed by insects, 42.8% were blighted or infertile, leaving only 21.% of normal seed.

In some localities, one specie was more predominant than another. For instance, the seed chalcidids were the most destructive insects in the region around Colestin, Oregon; the Evetria moth in the vicinity of Ashland Oregon; the pink caterpillars did the most damage to the cones from Northern Calif; while the Dicryctria moth was the most destructive insect in one locality in Colorado.

The maximum insect damage was in the vicinity of Colestin Ore. the seed chalcidids being the prime destroyers. Only ½ of 1% of good seed were found in these cones. While the smallest amount of insect damage was in the Sequoia Nat'l Park, Calif.

Taken on the whole, the Evetria moth did the greatest amount of damage to the entire White Fir seed crop of 1914, while the pink caterpillars the Dicryctria moths, and the seed chalcidids were almost equal destructiveness.

TABLE II.

Table showing Amount of Infestation In 1914.

The greatest number of insects, as shown by this table, were the seed chalcidids, with the loose Cecidomyids, the fungus gnats, the pink caterpillars, and the Fir seed maggots next in order.

The Evetria and Dicryctria moths averaged 1 to every 2 cones. The seed chlacidids averaged 20 to a cone; while the pink caterpillars averaged 2 to a cone.

76.8% of all cones were infested with seed chalcidids; 66.8% with

pink caterpillars, 36.6% with Dioryctria moths and 33.% with Evetria moths.

Every Evetria moth destroyed on the average 61.3 seeds; while the Dioryctria moths destroyed 40.7 seeds per insect and the pink caterpillars 12.3 seeds per insect. The seed chalcidids; the Fir seed maggots; the seed Cecidomyids and small white caterpillars only destroyed 1 seed to an insect.

CONTROL.

As yet no suggestions have been made for the control of these cones pests; and it is doubtful if any satisfactory artificial method of combating them in the forest will ever be found.

An English writer recommends controlling the seed chalcidids by placing the seeds in an air tight receptacle and fumigating with carbon bisulphide, as in the case of other stored seeds. This is probably suggested on the supposition that the chalcidids in the stored seeds would feed from one seed to another, a supposition which has by no means been proven. It si almost certain that the females can not oviposit in the hard seeds, but can only lay their eggs in the very young and tender seeds in the new cones. The carbon bisulphide fumigation would undoubtedly kill those insects contained in the already worthless seeds, but the few destroyed in this manner could have no appreciable effect in diminishing the countless numbers in the open forests.

Their natural enemies will have to be relied upon to hold them in their proper place. Birds destroy many; disease kills a few; while many more are parisitized by other insect. It was found that 26.1% of the Evetria moths and 27.9% of the Dioryctria moths were parisitized in 1914.

However, with a knowledge of the appearance, the life histories, and the characteristic work of these insects, and gerearal familiarity with the insects themselves, suggestions can be made to seed collectors as that losses may be avoided from the collection of badly infested seed.

*. Gillanders;- Forest Entomology.

As has been suggested by Mr. Miller in his Bulletin #95, areas, where seed collection is contemplated, should be examined during July and August before the seeds mature. The old cones, both on the trees and the ground will give evidence as to the prevalence of the insects in the area, and an examination of the new cones themselves will show whether the damage to the new crop is severe or not. By counting the damaged seeds, the collector can then determine whether the percent of damage is too high to make the collection of the seed profitable.

SUMMARY.

White Fir, which is one of the important Western forest trees, has suffered an increasing amount of insect damage to its cones and seeds, so that seed collection is no longer profitable and in some cases not possible.

The damage varies in different localities in any one year, and in each locality varies from year to year depending upon many conditions. In 1914 the principal area of infestation was in the vicinity of Ashland Ore., decreasing to the south into California and to the East. The best cone crop was in the Sequoia National Park, Calif.

The Evetria moth does the greatest amount of damage to the cones, while the seed chalcidids infest the greatest number of seeds. Besides the Evetria moth, the pink caterpillars, Dioryctria moths, and seed chalcidids are the other chief depredators. These last do nearly an equal amount of damage.

For the present the natural enemies will have to be relied upon to keep these insects under control.

However, loss thru the collection of infested seed may be avoided by an examination of the collecting area during July and August. With our present knowledge of these insects; their appearance in their different life stages; their life cycles and the character of their work; infestation may be readily recognized and badly infested areas avoided.

BIBLIOGRAPHY.

Butler, N. L:- North American Trees. 1908.

Engelman, George- A synopsis of the American Firs. (Transactions of the Academy of Science, St. Louis. 1878. Vol. III No. 4.

Frye, T. C. and Tiggs, G. B. Northwest Flora.

Gillanders:- Forest Entomology.

Jepson, W. L. - Silva of California.

Mamb, W. H, - Conspectus of North American Firs. (Exclusive of Mexico.)

Miller, J. M. - Insect Damage to the Cones and Seeds of Pacific Coast Conifers. Bull. U. S. Dept. of Agr. #95.

Sargent, C. S. Silva of North America.

Sudworth G. B. -Pacific Slope Trees.

TABLE II. TABLE SHOWING AMOUNT OF INFESTATION.

	LOT NUMBER.	NO. CONES EXAMINED.	EVETRIA MOTH	PINK LARVAE	DIORYCTRIA MOTH	SEED CHALCIDIDS	LONCHAEA RUFITARSIS	SEED CECIDOMYID	LARGE CONE MAGGOT	WHITE CATERPIL'RS	LOOSE CECIDOMYIDS	FUNGUS GNATS	SCALE CECIDOMYIDS	ICHNEUMON PARASITES	CLERIDAE	ANAESTIC CHALCIS
NUMBER OF INSECTS FOUND	12538-2	10	3	24	7	1072	4		2		22	15	10	1		1
	12560	31	30	60	17	83	68	35	1	13	117	134	54	5	2	1
	12564	10	3	38	3	211	22	20		2	10	1	12		1	
	12577	11	1	6	1	47	12	2			183	1	6			
	12563	10	6	12	4	221	1				21					
	12573	10	3	5	11	32	6				60					
	TOTAL	82	46	45	43	1666	115	57	3	15	386	151	82	6	3	2
AVERAGE NUMBER OF INSECTS PER CONE EXAMINED	12538-2	10	.3	2.4	.7	107.2	.4		.2		2.2	1.5	1.0	.1		.1
	12560	31	1.0	1.9	.5	2.7	2.2	1.1	.03	.4	3.8	4.3	1.7	.2	.0	.03
	12564	10	.3	3.8	.3	21.1	2.2	2.0		.2	1.0	.1	1.2		.1	
	12577	11	.1	.5	.1	4.3	1.1	.2			13.9	.1	.5			
	12563	10	.6	1.2	.4	22.1	.1				2.1					
	12573	10	.3	.5	1.1	3.2	.8				6.0					
	TOTAL	82	.56	1.77	.52	20.3	1.4	.7	.04	.18	4.6	1.84	1.0	.07	.04	.0
NUMBER OF CONES INFESTED	12538-2	10	1	9	6	10	4		2		5	4	3	1		1
	12560	31	17	25	13	14	19	14	1	6	20	6	15	5	2	1
	12564	10	1	7	2	9	5	7		2	6	1	7		1	
	12577	11	1	2	1	8	3	2			9	1	2			
	12563	10	5	7	3	10	1				6					
	12573	10	2	4	5	7	4				8					
	TOTAL	82	27	54	30	63	36	23	3	8	54	12	21	6	3	2
PERCENTAGE OF CONES INFESTED	12538-2	10	10.0	90.0	60.0	100.0	40.0		20.0		50.0	40.0	30.0	10.0		10.0
	12560	31	54.8	80.0	41.9	45.2	61.3	45.2	3.2	19.4	64.5	19.4	48.4	16.1	6.4	3.2
	12564	10	10.0	70.0	20.0	90.0	50.0	70.0		20.0	60.0	10.0	70.0		10.0	
	12577	11	9.1	18.2	9.1	72.7	27.3	18.2			81.8	9.1	18.2			
	12563	10	30.0	70.0	30.0	100.0	10.0				60.0					
	12573	10	20.0	40.0	50.0	70.0	40.0				80.0					
	TOTAL	82	33.0	65.8	36.6	76.8	43.9	28.1	3.7	9.8	65.9	14.6	32.9	7.3	3.7	2.4
NUMBER OF INSECTS PER INFESTED CONE	12538-2	10	3.0	2.8	1.2	107.2	1.0		1.0		4.4	3.8	3.3	1.0		1.0
	12560	31	1.8	2.4	1.3	5.9	3.6	2.5	1.0	2.2	5.8	22.3	3.6	1.0	1.0	1.0
	12564	10	3.0	5.4	1.5	23.5	4.4	2.9		1.0	1.7	1.0	1.7		1.0	
	12577	11	1.0	3.0	1.0	5.9	4.0	1.0			17.0	1.0	3.0			
	12563	10	1.2	1.7	1.3	22.1	1.0				3.5					
	12573	10	1.5	1.2	2.2	4.6	2.0				7.9					
	TOTAL	82	1.7	2.7	1.6	26.5	3.2	2.5	1.0	1.9	7.2	12.6	3.0	1.0	1.0	1.0

TABLE OF INSECT DAMAGE TO WHITE FIR SEED 1914.

INSECT SPECIES RESPONSIBLE FOR DAMAGE IN ORDER OF DESTRUCTIVENESS.																					INFESTED SEED		BLIGHTED SEED		GOOD SEED		TOTAL NO. SEEDS EXAMINED	NUMBER OF CONES EXAMINED	AVERAGE NO. SEEDS EXAMINED PER CONE	REMARKS.
EVETRIA MOTH			PINK CATERPILLAR			LONG RED CATERPILLAR			SEED CHALCIDID			LONG DIPTERA			SEED CECIDOMYID			LARGE DIPTERA			SMALL WHITE CATERPILLAR										
SEEDS INJURED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INJURED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INJURED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INFESTED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INFESTED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INFESTED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INJURED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS INJURED	% OF INSECT DAMAGE	% OF SEED DAMAGE	SEEDS	PERCENT	SEEDS	PERCENT	SEEDS	PERCENT			
1709	46.5	22.7	1087	29.5	14.5	669	18.2	8.9	83	2.3	1.1	72	2.0	.9	35	.9	.5	10	.2	.1	13	.4	.2	3678	48.9	3288	43.9	542	7.2	7508	31	242	U. S. Hopk. 12560 Ashland, Oregon. Sept. 2, 1914
100	5.7	3.1	176	10.0	5.5	296	16.8	9.3	1072	60.8	33.6	75	4.2	2.4	2	.1	.1	42	2.4	1.3				1763	55.3	1411	44.2	18	.5	3192	10	319	U.S.Hopk. 12538-lot 2 Colestin, Oregon. Aug. 22, 1914
94	10.7	3.5	403	45.7	15.0	116	13.2	4.3	211	23.9	7.8	35	4.0	1.3	20	2.3	.8				2	.2	.1	881	32.8	1143	42.6	660	24.6	2684	10	268	U.S.Hopk. 12564 McKinney Creek, Calif. Sept. 3, 1914
64	39.5	2.1	19	11.7	.6	18	11.2	.6	47	29.0	1.6	12	7.4	.4	2	1.2	.1							162	5.4	1054	35.1	1784	59.5	3000	11	273	U.S.Hopk. 12577 Sequoia Nat'l Park,Cal Sept. 24, 1914.
286	39.2	10.3	65	8.9	2.3	158	21.6	5.7	221	30.2	8.0	1	.1											731	26.3	1291	46.5	754	27.2	2776	10	278	U.S.Hopk. 12563 El Paso Co. Colo. Sept. 3, 1914.
107	16.0	4.0	25	3.7	.9	494	73.9	18.2	32	4.8	1.2	11	1.6	.4										669	24.7	1203	44.5	835	30.8	2707	10	271	U.S.Hopk. 12573 El Paso Co. Colo. Sept. 16, 1914.
2360	29.9	10.9	1775	22.5	8.1	1751	22.2	8.0	1666	21.1	7.6	206	2.6	1.0	59	.8	.3	52	.7	.2	15	.2	.1	7884	36.2	9390	42.8	4593	21.0	21,876	82	267	TOTALS.

SUMMARY OF IMPORTANT DATA SHOWN IN TABLE.

	Total Number Examined.	Percent.
Good Seed	4593	21.0 %
Blighted Seed	9390	42.8 %
Infested Seed	7884	36.2 %
Total examined	21,867	100.0 %
Number of cones examined	82	
Average number of seed per cone	267	

INSECTS RESPONSIBLE FOR THE ABOVE INFESTATION:-

	No. seed examined infested	% of Insect damage done by species.	% of Seed crop damaged.	Lot containing maximum of each species.	Maximum % of seed damaged.
Evetria moth	2360	29.9	10.9	12560 Ashland, Ore.	22.7
Pink larvae	1775	22.5	8.1	12564 McKinney Crk, Cal.	15.0
Long red larvae	1751	22.2	8.0	12573 El Paso Co. Colo.	18.2
Seed chalcidid	1666	21.1	7.6	12538-2 Colestin, Ore.	33.6
Long Diptera	206	2.6	1.0	12538-2 Colestin, Ore.	2.4
Seed Cecidomyid	59	.8	.3	12564 McKinney Crk, Cal.	.8
Large Diptera	52	.7	.2	12538-2 Colestin, Ore.	1.3
Small White Larvae	15	.2	.1	12560 Ashland, Ore.	.2
TOTAL	7884	100.0	36.2		

MAXIMA AND MINIMA:-

Maximum damage to seed from one species, done by seed chalcidid in Lot. 12538-2 from Colestin, Ore. destroying 33.6 % of all seeds in this locality.

Maximum infestation:-Lot 12538-2, Colestin, Ore. 55.3 % Infested Seed.

Minimum infestation:- Lot 12577, Sequoia Nat'l Park, Cal. 5.4 % Infested Seed.

Maximum of Blighted Seed:- Lot 12563, Colorado 46.5 % Blighted.

Minimum of Blighted Seed:- Lot 12577, Sequoia Nat'l Park, Cal. 35.1 % Blighted.

Maximum Good Seed:- Lot 12577, Sequoia Nat'l Park, Calif. 59.5 % Good Seed.

Minimum Good Seed:- Lot 12538-2 Colestin, Ore. .5 % Good Seed.

SUMMARY:-

The data of this report seems to show that the principle area of infestation was in the vicinity of Ashland, Ore; and that the damage decreased to the South in California; that the cone crop in the Sequoia National Park California was exceptionally good; that the Colorado cone crop had suffered less than that in Southern Oregon and Northern Calif.

The data indicates that all cones had about an equal share of infertile or blighted seed and that the rest of the seed were either good or insect infested.

The evidence tends to show that the Evetria moth did the greatest damage to the cones, while the seed chalcidids infested the greatest percent of seeds. The seed chalcidids were responsible for the greatest percent of damage done to a single lot of cones by any one insect. In a sample of cones from Colestin, Ore they had destroyed 33.6 % of the entire seed crop. While the highest percent of damage done by the Evetria moth to any single lot was only 22.7 % of the entire crop. But since its work was more general, on the whole, it did the greatest amount of damage of any cone infesting insect.

(Signed) F. Paul Keen.

Entomological Ranger.

Approved:-

Entomological Assistant.

In Charge Pacific Slope Sub-Station.